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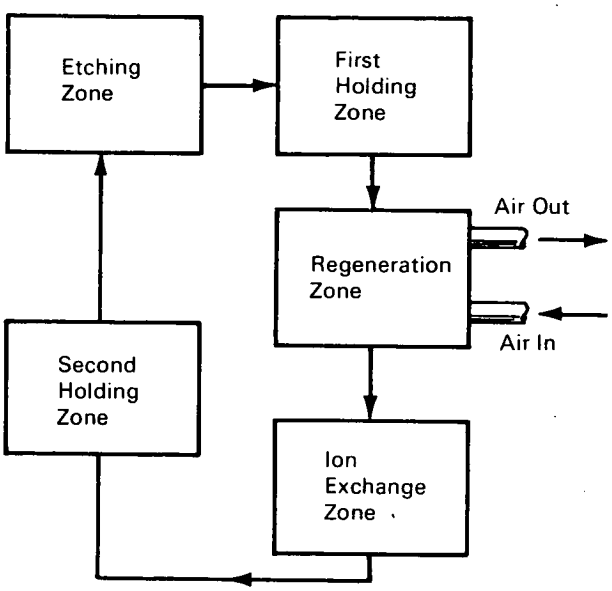
NASA TECH BRIEF

Controlled Etching of Printed-Circuit Boards



A method has been developed for etching copper from the surface of printed-circuit boards at a controlled rate using ferric chloride in an aqueous medium as the etchant. As the etching process proceeds, ferric ions are reduced to ferrous ions, resulting in a reduced etching rate. In the present method, the desired concentration ratio of ferric to ferrous ions is maintained by contacting the ferrous ions with oxygen in the presence of ultraviolet light.

In operation, a printed-circuit board having copper on at least one surface is placed in the etching zone which contains a metal ion at a first valence (e.g., ferric ion in acidic solution). The ferric ion acts as an oxidizing agent to etch copper from the surface to form cupric ion while ferric ion is reduced to ferrous ion, an ion of lower valence state than ferric ion. As initial ferric ion concentration declines, and continuously thereafter, part of the etching solution is passed to the first holding zone where it is stored for a predetermined time to control flow. The etching solution containing ferrous ions passes from the first holding zone to a wetted-transparent-surface regeneration zone which is surrounded by ultraviolet light sources (not shown in the block diagram) and supplied with a constant flow of air. The solution flows in a thin film over the transparent surface of the regeneration zone where, by simultaneous contact with oxygen and ultraviolet radiation, ferrous ion is oxidized to ferric ion by:

$$2Fe^{+2} + 1/2\,O_2 + 2H^{+} \xrightarrow[\text{light}]{\text{ultraviolet}} 2Fe^{+3} + H_2O.$$

The solution passing from the regeneration zone to the ion exchange zone contains a substantial concentration of a ferric anion complex. As the solution passes through the ion exchange zone, an ion exchange resin such as sulfonated styrene-divinylbenzene copolymer adsorbs most of the copper picked up in the etching zone, while most of the ferric anion complex passes to the second holding zone, again for flow control, and then back to the etching zone to repeat the process. Copper is periodically recovered from the resin in the ion exchange zone by washing with hydrochloric acid, which simultaneously regenerates the adsorptive capacity of the resin.

Notes:

1. Any iron adsorbed by the ion exchange resin can be recovered by washing the resin with an acid solution having a pH no greater than 2.5.
2. Additional hydrochloric acid is added to the etching solution periodically to maintain its pH below 7, and, preferably, between 1.0 and 2.5. The etching solution is maintained at saturation concentration with respect to ferric chloride by the continuous regeneration of ferric ion by this process.

(continued overleaf)

3. No additional documentation is available. Technical questions, however, may be directed to:

Technology Utilization Officer
Goddard Space Flight Center
Greenbelt, Maryland 20771
Reference: B70-10327

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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